Cyanides in protoplanetary disks: Fractionation and photochemistry

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The physical and chemical structure of protoplanetary disks, including the radiation field and gas temperature, can be probed by the emission and spatial distribution of molecules. Theoretical models predict that the vertical and radial attenuation of the radiation field will result in a vertical and radial stratification of molecules, where radicals like CN will dominate the UV-illuminated disk surface and the outer low-density disk, where radiation can penetrate to the disk midplane, while molecules such as HCN are mainly present in a protected layer between the disk surface and the cold midplane. The CN/HCN ratio can thus be used to constrain the radiation field in disks and how this relates to the disk density profiles. HCN and CN isotopologues are additionally potential probes of the disk thermal structure since 15-N fractionation should depend sensitively on the formation temperature — higher fractionation is expected in colder environments. We will present ALMA observations of CN, HCN and isotopologues, at high-angular resolution (~0.6”), in two protoplanetary disks — DM Tau and MWC 480 — exposed to different stellar radiation fields. We find that, in agreement with model predictions, the CN/HCN ratio increases with radius. We also find interesting sub-structures suggestive of a complex radial dust and/or radiation profile. We also provide the first measurement of the 14-N/15-N ratio in a disk. We find a low 14-N/15-N ratio, i.e., high fractionation in MWC 480, comparable to what is observed in comets.

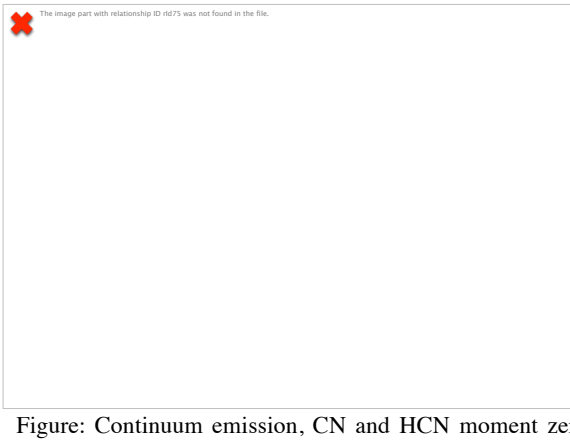

Figure: Continuum emission, CN and HCN moment zero maps in MWC 480 (upper), and radial profiles (bottom).